In-Situ Spectroscopic Characterization of Acidic Sulfate Deposits of Rio Tinto, a Mars analog

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We are investigating the Rio Tinto as an astrobiological site with relevance to Mars. Rio Tinto is a 100-km river near Huelva, Spain, with a pH of ~2.0, high concentrations of heavy metals and a flourishing diverse microbial community. Through diagenesis and dehydration, jarosite, a dominant mineral type, transforms to goethite and coarse-grained hematite (Fernández Remolar et al, 2002, 2004). The Rio Tinto is an important analogue for Terra Meridiani, providing a possible mechanism of formation of the sulfate and hematite rich mineralogy.
We are developing spectroscopic approaches that will help in identifying key indicator minerals of similar environments for exploration of Mars. The recent results from the Opportunity Rover indicate that iron-sulfur systems may have been important in early Mars, and thus, developing quantitative exploration criteria in Mars analogs will be helpful in interpreting OMEGA and CRISM data.

Acidic and heavy metal-rich environments provide insight to the limits and modes of life. Bacteria can obtain energy through sulfur and iron oxidation in such extreme environments to optimize growth, producing acidic brines, and precipitating sulfates by secondary physical-chemical processes (Fernández Remolar 2003). We are investigating the relationships between these biological systems, the minerals deposits, and the spectroscopic signatures. Sulfate and iron oxide mineralogy have distinctive crystal field and vibrational absorption features, lending themselves to analysis by reflectance spectroscopy. Combining spectral data with biological data can help us better characterize the geochemistry and history of these extreme environments. Applying the unique spectral signatures from the mineral associations at Rio Tinto to OMEGA and future CRISM data of Mars will identify sites of potential astrobiological significance. We present spectra from iron and sulfate-rich deposits investigated during recent field work in Rio Tinto, Spain; expected mineralogy includes Fe oxyhydroxides, Fe oxyhydroxysulfates and evaporitic Fe sulfates (Buckby et al., 2003).

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